

CLAIMS

I claim:

Sub A1 → 1. A method of predicting future locations of a moving object, comprising the steps of:

5 receiving a current location of the moving object;
obtaining a destination of the moving object;
computing a path between the current location and the destination; and
constructing a trajectory for the moving object.

10 2. A computer readable medium having stored therein instructions for causing a central processing unit to execute the method of claim 1.

3. The method of claim 1, further comprising the step of:
sending the trajectory to the moving object.

15 4. The method of claim 1, further comprising the step of:
sending a map to the moving object.

5. The method of claim 4, wherein the map contains permissible travel
20 segments for the moving object, and wherein the map further contains an estimated travel
time and a travel distance for each permissible travel segment.

6. The method of claim 1, further comprising the steps of:

receiving an updated location of the moving object;
recomputing the path based at least in part on the updated location and the
destination; and
constructing an updated trajectory for the moving object.

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7. The method of claim 6, wherein the step of recomputing the path is also
based on an error.

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8. The method of claim 6, wherein the step of recomputing the path is also
based on an error, and wherein the step of recomputing the path is performed when the
error reaches a threshold.

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9. The method of claim 1, wherein the path represents the shortest distance
between the current location and the destination.

10. The method of claim 1, wherein the step of computing a path determines
travel times for possible paths and determines a fastest travel time.

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11. The method of claim 1, wherein the step of computing a path is performed
by another computer system.

12. The method of claim 1, wherein the step of computing a path further
comprises:

sending the current location and the destination to a remote system; and
receiving the path from the remote system.

13. The method of claim 1, further comprising the steps of:

5 receiving a traffic update;

adjusting at least one travel time in a map, wherein the adjustment is based on the
traffic update, and wherein the map is used in computing the trajectory; and
recomputing the trajectory.

10 14. The method of claim 13 wherein the step of adjusting at least one travel
time is performed using a traffic incident duration model, and wherein the traffic incident
duration model estimates the length of a traffic incident.

15 15. The method of claim 1, further comprising the step of:

calculating a future location of the moving object, wherein the calculation is
performed using the trajectory.

20 16. The method of claim 1, wherein the current location is received from the
moving object.

17. The method of claim 1, wherein the moving object is a cellular phone, and
wherein the current location is received from a tracking authority.

18. A method of determining trajectory of a moving device, comprising the steps of:

obtaining a first location of the moving device;

obtaining a destination of the moving device;

5 computing a path between the first location and the destination, wherein the computation is performed using an electronic map which contains travel paths between points, and wherein the shortest path is a sequence of travel paths; and
simplifying the path to create a first trajectory.

10 19. A computer readable medium having stored therein instructions for causing a central processing unit to execute the method of claim 18.

20. The method of claim 18, wherein the step of simplifying the path is done using line simplification.

15 21. The method of claim 18, wherein the step of simplifying the path is done by coalescing adjacent travel paths in the path that have the same travel speed and direction to create an estimated trajectory, and wherein the trajectory is a compilation of line segments connecting the first location and the destination.

20 22. The method of claim 18, wherein the step of computing a path is performed by sending the first location and the destination to a remote device, and wherein the remote device computes the path and sends the path to the database.

23. The method of claim 18, further comprising the steps of:
receiving a second location of the moving device;
computing an updated path, wherein the updated path is based on the second
5 location and the destination; and
calculating an updated trajectory, wherein the updated trajectory is based on the
updated path.

24. The method of claim 18, further comprising the steps of:
10 associating an uncertainty with each line segment in the trajectory; and
calculating an overall uncertainty, wherein the overall uncertainty is based on the
uncertainties for each line segment.

25. The method of claim 24, further comprising the steps of:
15 receiving a second location;
computing an updated shortest path, wherein the updated shortest path is based on
the second location and the destination;
calculating an updated trajectory, wherein the updated trajectory is based on the
updated shortest path;
20 associating an uncertainty with each line segment in the updated trajectory; and
calculating an overall uncertainty, wherein the overall uncertainty is based on the
uncertainties for each line segment in the updated trajectory.

26. The method of claim 18, further comprising the step of:
computing a future location of the moving device based on the trajectory.

27. The method of claim 18, further comprising the steps of:
5 receiving a traffic update;
computing an updated shortest path based on the traffic update; and
simplifying the updated shortest path to create a new trajectory.

28. The method of claim 27, wherein the step of computing an updated
10 shortest path is performed using a model to estimate a traffic incident duration.

29. A method of creating and updating trajectory of a moving device,
comprising the steps of:
determining a first location of the moving device;
15 transmitting the first location of the moving device to a database;
receiving a trajectory from the database;
computing an anticipated location based on the trajectory;
determining a second location of the moving device; and
calculating a difference between the anticipated location and the second location.

20 30. A computer readable medium having stored therein instructions for
causing a central processing unit to execute the method of claim 29.

31. The method of claim 29, further comprising the step of:
transmitting the second location to the database, wherein the second location is
transmitted when the difference exceeds a threshold.

5 32. The method of claim 29, further comprising the step of:
determining a third location, wherein the third location is determined when the
difference exceeds a threshold; and
transmitting the third location to the database.

10 33. The method of claim 29, wherein the moving device is a cellular phone.

34. The method of claim 29, wherein the moving device is a personal digital
assistant.

15 35. The method of claim 29, wherein the moving device is a computer.

36. The method of claim 29, wherein the step of determining a first location
and determining a second location are performed using a global positioning system.

20 37. The method of claim 29, wherein the steps of determining a first location
and determining a second location are performed manually by a user.

38. A method of creating and updating a trajectory of a moving device,
comprising the steps of:
determining a first location of the moving device;
transmitting the first location of the moving device to a database;
5 computing a trajectory;
calculating an anticipated location based on the trajectory;
determining a second location of the moving device; and
calculating a difference between the anticipated location and the second location.

10 39. A computer readable medium having stored therein instructions for
causing a central processing unit to execute the method of claim 38.

40. The method of claim 38, further comprising the step of:
receiving a map from the database.

15 41. The method of claim 38, wherein the step of computing a trajectory is
performed using a map stored in the device, and wherein the map contains travel
distances and travel times for permissible travel paths.

20 42. The method of claim 38, further comprising the steps of:
determining a destination of the moving device;
transmitting first location and the destination to a remote system; and

receiving a path between the first location and the destination from the remote system.

5 43. A method of tracking a moving device, comprising the steps of:
obtaining a first location and a first orientation of the moving device;
projecting a path for the moving object; and
computing a trajectory of the moving device.

10 44. A computer readable medium having stored therein instructions for
causing a central processing unit to execute the method of claim 43.

15 45. The method of claim 43, wherein the step of projecting a path assumes the
moving object will continue to travel on the same road segment at a speed until the
moving object sends an updated location based on an error threshold.

46. The method of claim 43, wherein the step of projecting a path assumes the
moving object will continue to travel in the same direction until the moving object sends
an updated location.

20 47. The method of claim 43, further comprising the steps of:
receiving a second location and a second orientation of the moving device;
projecting a second path for the moving object; and
computing an updated trajectory of the moving device.

48. The method of claim 47, wherein the step of projecting a second path uses dead reckoning on major roads.

5 49. The method of claim 47, wherein the step of projecting a second path uses periodic updates on minor roads.

10 50. A trajectory computation system, comprising:
a database server for receiving location information of a moving object, storing the location information of the moving object, and processing query requests;
a trajectory server for creating a trajectory of the moving object; and
a map server for storing travel paths between points, where each travel path has associated with it a distance and a travel time.

15 51. A system for anticipating the trajectory of a moving object, the system comprising:

an input client for receiving location data from the moving object;
an interface server for connecting with the input client; and
an application server, where the application server is connected to the interface
20 server, where the application server stores the location data, and where the application server computes an expected trajectory of the moving object; and
a map server, where the map server stores travel paths for a geographic region, where each travel path has with it an associated distance and time, and where the map

server provides the travel paths to the application server for computation of the expected trajectory.

52. The system of claim 51, wherein the input client is a WWW client for
5 receiving location data sent over the Internet.

53. The system of claim 51, wherein the input client is a PDA client for
receiving location data sent from a personal digital assistant.

10 54. The system of claim 51, wherein the input client is a wireless client for
receiving location data sent from a wireless communications device.

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